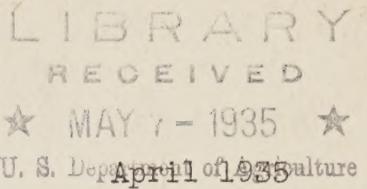


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INSECT PEST CONTROL FOR THE AMATEUR MUSHROOM GROWER

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During the past few years considerable interest has been shown in the cultivation of mushrooms in cellars or other suitable places around the home. As a result many inquiries are now being received for information on the control of insects and other pests that attack this crop.

One of the principal difficulties confronting the amateur who contemplates growing mushrooms in small quantities in a cellar, barn, or other structure, is that of properly composting small quantities of manure. This procedure is intimately related to the control of mushroom pests. Severe infestations of flies, mites, and springtails may result from eggs and larvae being carried into the beds with compost, if the compost is not in proper condition to go through a good secondary fermentation, or "heat", in the beds to raise the temperature to a point where insects and mites are killed. A half ton of manure is sufficient for from 35 to 45 square feet of mushroom bed, and it is extremely difficult to secure proper curing of less than this amount. One of the advantages of growing mushrooms upon a small scale is the practicability of screening the small compost heaps with cheesecloth to exclude insects; another is the ease with which a small composting floor of cement or of 2 by 12 inch planks may be constructed, thus preventing the entrance of insects from the soil.

CONSTRUCTION

The place in which mushrooms are to be grown should be separated from the rest of the building by partitions insulated with sawdust or cork, if possible, but in any case made as tight as possible with building paper or other material. In constructing the beds a space of at least a foot should be left between the floor and the bottom of the lowest bed. This permits the bottom bed to heat better and facilitates cleaning the floor thoroughly after filling. Beds built upon the floor cannot be heated properly and are therefore very difficult to free from insect pests.

DISINFECTION

Between crops the cellar should be thoroughly cleaned out, the beds dismantled, and the boards scraped, brushed, and painted, or sprayed with a solution of 1 pint of fresh formalin in 15 gallons of water. Some growers use a lime and copper sulphate wash for this purpose. These materials are effective germicides and fungicides, but are not of much value against insects. Where facilities are available, steam, electric, or oil heat may be used for the eradication of insects at this time. A temperature of 120° to 125° F., if maintained for a few hours, should effectively rid the cellar of all insects. A 16-inch electric fan with

the blades directed upward at an angle of 45 degrees should be kept running during this time to distribute the hot air evenly, otherwise the top of the space will be very hot and the air for a few inches above the floor will be too cool to kill the insects. In places away from dwellings, fumigation with flowers of sulphur, burned at the rate of 5 or 6 pounds per 1,000 cubic feet of air space, may be substituted for both spraying and heat, and is more satisfactory. The sulphur should be burned in a metal tray or other container of such size and depth that the molten sulphur will not flow out and set fire to the bed-supports. If the pan containing sulphur is placed in a larger pan filled with water, the danger from fire will be still further reduced. Excelsior or crumpled paper should be placed in the pan and the sulphur sifted over it. This promotes more complete and rapid combustion. Plenty of room should be allowed above the pan, as the excelsior or paper may flare up fairly high. Sulphur fumigation cannot be recommended for fumigating cellars unless they can be sealed off tightly enough to prevent all fumes from working up through the floors into the dwelling above. Sulphur should not be used where there is any possibility of the fumes reaching mushroom beds in production, as the growing mushrooms will be damaged.

FILLING THE BEDS

The beds should be filled as quickly as possible, all spilled manure cleaned from the floor, and the room closed tightly. After manure is placed in the beds it undergoes a secondary fermentation which raises the temperature. Owing to the small quantity of manure and the insufficient insulation in the usual mushroom cellar, the temperature does not go high enough to put the manure into the best shape, or to kill the insects. This may be corrected by heating the room prior to filling the beds and by raising the temperature artificially during the fermentation by means of electric or steam heat, but care should be taken that the compost does not dry out too much. The use of oil heaters should usually be avoided, as oil fumes sometimes have a harmful effect upon mushroom growth. An electric fan directed obliquely upward should be run in the room during this period to distribute the heated air evenly. From preliminary results of experiments now being conducted it seems fairly safe to say that an air temperature of 120° to 125° F., if maintained for a few hours, and if evenly distributed through the room, will kill all insects harmful to mushrooms. The manure in the beds will reach a much higher temperature during this time, but should not be allowed to go over 140° F. A temperature of 120° F. for 48 hours will eradicate the "bubbles" disease (mycogone) also.

During the heating of the compost in the beds much moisture is driven off. In basements of dwellings it is inadvisable to try to reach a high temperature unless the room can be sealed tightly enough to prevent the moisture and heat from warping the floor above.

SANITATION

After the manure is in the beds, great care should be used that insects are not introduced. Doors and other openings should be covered

with 30-mesh copper screen or with cheesecloth to prevent entrance of mushroom flies.

INSECT PEST CONTROL

After the beds have been cased, the temperature should be kept rather low. For the best results it should be possible to maintain the room at 50° to 55° F. A temperature below 55° F. is more to be desired than one above, as the lower temperature seems to be the most favorable for mushroom growth, and is low enough to retard materially the development of insect pests.

Once the beds have become infested with insects, it is extremely difficult to kill them, as the chemicals used for control either do not penetrate the compost readily or have a harmful effect upon the mushrooms. Persons growing mushrooms in cellars, which are usually quite unsuitable for fumigation, are particularly dependent upon prevention of insect infestation rather than control.

Control of individual species of pests is discussed under separate headings.

Sciarid flies

The sciarid flies, also known as "fungus gnats", of the family Mycetophilidae, are, all things considered, probably the most important pests of mushrooms. There are at least four species of these that may do damage in mushroom beds, but all are much alike in appearance and habits and may, for practical purposes, be treated as one species. The adult flies are from 1/16 to 1/10 inch or more in length, gray-black or yellow-black in color. The legs and antennae are rather long and slender and the wings are customarily carried folded flat on the back. The eggs of these flies are about 1/64 of an inch in length--barely visible to the naked eye--oval, and shining white. They are laid in the compost, or about the bases of the mushrooms and in cracks in the casing soil after the beds are cased. The larvae are white or yellowish, semitransparent, legless maggots with small, shiny-black head capsules. When fully grown they are about 1/4 inch in length. It is these maggots that are injurious, feeding upon the spawn in the beds and eventually consuming all of it and reducing the compost to a soggy, semiliquid mass. If the infestation becomes at all heavy, the larvae will also burrow through the mushrooms, making them unfit for use.

Prevention of infestation is more to be desired than control, since there is no satisfactory method known by which the maggots in the beds may be destroyed without injuring the growing spawn. By controlling the adult flies, oviposition may be prevented to some extent, and the subsequent increase of larvae in the beds cut down materially. The most effective method of control of adult flies known at present is by dusting with a mixture of 60 percent of pyrethrum and 40 percent of diatomaceous earth at the rate of 2 or 3 ounces per 1,000 cubic feet of air space. Several brands of this type of dust are on the market. It is

important that dusting be started early, as soon as the first flies appear. If it is delayed until flies are numerous, much damage will already have been done. Where it is possible to use it, calcium cyanide, at the rate of 1-1/2 to 2 ounces per 1,000 cubic feet of air space, is quite effective against adult flies. This should not be used in cellars under dwellings, however, and in no case should more than 2 ounces per 1,000 cubic feet be used, as even a rather low concentration of gas will injure the growing mushrooms. If used too often, the hydrocyanic acid gas generated from calcium cyanide, even at this concentration, is said to injure the spawn. The temperature should be allowed to rise to around 60° F. for most effective results with either the calcium cyanide or the pyrethrum dust.

Flies are attracted to light if it is not too strong, and light traps have been used to good advantage in commercial houses. The simplest of these consists of fly paper, or paper upon which tree-banding material has been smeared, hung about an electric light or fastened about a small aperture into which a pane of glass has been fitted to admit daylight. In the latter case a pan of kerosene may be used to good advantage instead of fly paper, placing it beneath the opening so that flies coming to the light will fall into it.

Phorid flies

There are several species of flies of the family Phoridae that sometimes do considerable damage to mushroom beds. The adult flies are black or blackish in color and usually somewhat smaller than the sciarid flies. They are much more compactly built, the legs stouter and not so long, the head rather small, and the thorax large, giving them a hump-backed appearance. They are quite active, moving about constantly in a series of jerky runs. The egg is very minute, white, elongate-oval, and is usually laid in the compost. The larva, or maggot, is shining white or yellowish, about one-fourth inch long when fully matured, legless, and without a head capsule.

The infestation of mushroom beds by phorid flies usually results from larvae being introduced with compost which afterward does not get sufficiently heated to kill them, or from eggs laid by adults which get into the house immediately after the heating. The damage is done by the larvae and is about the same as that done by the sciarid larvae, except that, being early, the spawn may be prevented from running out from the spawn pieces, or the pieces themselves destroyed. The larvae also attack the growing mushrooms more readily than the sciarid larvae. Most of the damage is done early in the season, usually becoming less noticeable after the beds are producing, although during the warm weather at the end of the spring crop much damage may be done to both spawn and growing mushrooms.

Control of Phoridae is about the same as for Sciaridae, except that dusts must be used somewhat more liberally, the flies being more resistant to control measures.

All varieties of mushroom flies, in addition to the direct damage done by the larvae, may be responsible for the introduction of mushroom diseases and mushroom mites into the beds. The spores or germs of diseases

have been shown to be carried by the flies, and the mites in a certain stage of development make a practice of "stealing rides" upon flies, and thus may be widely scattered.

Mushroom mites

There are four species of mites that have been found damaging mushrooms.

The mushroom mite, Tyroglyphus lintneri Osborn, is the most common and widely distributed one. These mites are very tiny, white or yellowish in color, and resemble small grains of white sand or sugar in the compost. They feed upon the spawn in the beds, and where at all numerous may prevent it from running satisfactorily. They may also chew holes in the caps of the mushrooms. The damage done by mites often is not so evident as that done by other pests, and the mites themselves, being so small, often escape notice, and infestation shows only in reduced yields.

It is important that the beds (and room) go through a good "heat", as the mites are nearly always present in the manure and can be controlled most effectively by killing them at this time. There is no very effective method of controlling them after the beds have started producing. Paradichlorobenzene, at the rate of 1 1/2 to 2 pounds per 400 square feet of bed space, has been used successfully in some cases. Best results have been obtained by cleaning off the beds, covering them with cheesecloth, broadcasting the material over this, and covering it with paper, which should be left on the beds for several days. No damage to mushroom growth was noted in cases where small sections of bed were used, even where these were kept damp, but damage has been reported in some cases following this treatment. Until more is known concerning the use of this substance, it would be advisable to experiment with a small section of bed to note the effect upon the mushrooms before treating the whole bed.

The long-legged mite, Linopodes antennaeipes, Banks, is less common than the preceding one, but is extremely difficult to control. It is likely to be a serious pest where it is found. The body is very minute, yellow to reddish-brown in color, and the legs, especially the front pair, are very long and slender. This species feeds upon the spawn to some extent, but the principal and most evident damage is done by the mites chewing off the feeder roots of the growing mushrooms, causing the stems to constrict at the base, and injuring or killing the developing mushroom.

This species of mite is easily killed by heat, having been found to succumb to 100.4° F. for one-half hour at a relative humidity of 89 percent. If the temperature along the floor does not reach this height, however, the mites there will recover and reinfect the beds. They are very active, and are capable of crawling into cracks in the floor and walls to escape the heat. Paradichlorobenzene may be used against them with some success.

In addition to the two mites mentioned above, Rhizoglyphus phylloxerae Riley and Histiostoma sp. have been noted as sometimes attacking mushrooms. The control methods used against the other mites would probably be effective against these.

Springtails

A number of species of springtails are found in mushroom beds, and all are capable of doing damage to spawn and mushrooms throughout the season. They are, in general, very small gray, blackish, or brown insects, from about 1/64 to 1/16 of an inch in length. Beneath the abdomen there is a powerful spring which, when released, is capable of hurling the insect through the air for a distance many times its own length. Some springtails have a habit of congregating in immense numbers, looking like piles of gray powder. They usually get into the beds with the compost, but may enter later through cracks in the walls. They are easily killed by heat. In the case of Lepidocyrtus lanuginosus (Gmel.), a springtail found doing damage in commercial houses in Ohio, it has been determined that 40° C. (approximately 104° F.) for 10 minutes will kill most, if not all of them. Paradichlorobenzene used in the same manner as for mites for 48 hours is said to give good control. Springtails on the surface of the beds may easily be killed with a lime dust containing 3 percent of free nicotine, but this does not reach those within the beds.

Sowbugs

Sowbugs, also known as "pillbugs" and "woodlice", are elongate, convex, slate-gray in color, with seven pairs of legs. Fully grown ones may be one-half inch in length. They occasionally become numerous enough in mushroom beds to cause some damage by eating holes in the buttons and in the caps of matured mushrooms. In a cellar or other small area it is possible to control them by hand-picking them off the beds. Where they congregate in clusters along the edges of the beds, hot water may be poured upon them. Nicotine or pyrethrum dusts will also give control if they actually come in contact with the sowbugs. Derris used as a dust or spray probably will give good control also under similar conditions. In using dusts, the beds should be allowed to dry slightly, and not be watered for 24 hours or so after the application.

Slugs

Slugs seldom become numerous enough to be of importance, but where they do, hand-picking is the most effective remedy.

Crickets

Crickets sometimes become pests in mushroom beds by eating holes in the caps. Usually they are not difficult to discover and destroy.

Nematodes

Nematodes, or "eelworms", are not uncommon in mushroom beds, especially in the Middle West. They are very small, threadlike worms which cause brownish watery spots or nodules on the caps of the mushrooms. No effective means of control for these pests has yet been devised.